Abstract:

Spaceborne GNSS Radio Occultation Instrumentation for Operational Applications

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Radio occultation (RO) instruments using GPS (or in general GNSS) as the source of opportunity are specialized spaceborne GNSS receivers designed to provide highly accurate measurements of vertical profiles of the temperature, pressure and humidity in the atmosphere, as well as profiles of electron content in the ionosphere.

A family of high performance RO instruments is being developed for a number of European space projects since 1996. The projects include: the three Metop satellites for operational meteorology, which originate from a joint program between Eumetsat (European Organization for the Exploitation of Meteorological Satellites) and ESA (European Space Agency); the Atmospheric Climate Experiment (ACE), a constellation of micro-satellites being developed by ESA; and the ESA participation in the Japanese GCOM Earth remote sensing program. The instrument developed for such missions is generically indicated as the GNSS Receiver for Atmospheric Sounding (GRAS), although differences exist between the various missions. In addition, following an international competition and based on the GRAS development, SAAB Ericsson Space have been selected by the US Integrated Program Office (NOAA, NASA, DOD) to develop the GPS Occultation Sensor (GPSOS) for the US National Polar Orbiting Environmental Satellite System (NPOESS).

The basic functions of the GRAS instrument include: reception of signals that have crossed the atmosphere at varying altitudes by means of two antenna arrays; acquisition of such signals, also during the (problematic) rise RO events, when a signal first appears after crossing dense tropospheric layers that cause large dynamics in its amplitude and phase; robust signal tracking to provide precise amplitude and phase measurements; on-board processing to support RO event predictions, also with respect to characteristics of each event whose knowledge can aid the tracking process.

Optimized antenna array patterns ensure reception of almost all useful RO events with high gain. The RF front ends provide high sensitivity and rejection of on-board interferers. Measurements at low signal level are also supported by linear parameter estimation techniques. Dual frequency measurements in codeless tracking mode are used to determine ionosphere parameters. The GRAS architecture makes use of digital signal processing also in the RF part to achieve digital down conversion and filtering of the signals prior to their processing in a dedicated GPS/GLONASS ASIC.

The paper will summarize the main requirements on the instrument and will illustrate the main technical features adopted. The expected performance and the evolution of the instrument family will also be presented. Finally, some considerations will be given on the impact of RO measurements for weather prediction and climate monitoring following the launch of the first operational RO instrument on Metop 1 in 2003.

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